DOCUMENT RESUME

ED 332 672 IR 014 988

TITLE	Images in Action. Learning Tomorrow: Linking Technology and Restructuring.
INSTITUTION	National Foundation for the Improvement of Education, Washington, D.C.
PUB DATE	91
NOTE	40p.; For the report on Phase I, see ED 319 383.
AVAILABLE FROM	National Foundation for the Improvement of Education Publications, PO Box 509, West Haven, CT 06519 ($4.00).
PUB TYPE	Viewpoints (Opinion/Position Papers, Essays, etc.) (120) -- Reports - Descriptive (141)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Computer Assisted Instruction; Educational Environment; *Educational Practices; *Educational Technology; Educational Trends; Elementary Secondary Education; *Instructional Innovation; Multimedia Instruction; School Restructuring
IDENTIFIERS	*Learning Tomorrow Project

ABSTRACT

Focusing on the use of advanced technologies in classrooms to reshape the educational environment in which students learn, this report on Phase II of the Learning Tomorrow program contains brief descriptions of the most promising educational practices submitted by teachers in response to two nation-wide calls for Innovation in Practice. The report begins with background image and two discussions: "Starting Points" and "Technology: A Catalyst for Restructuring." An outline of 12 common themes or elements of alternative organization of education identified in Phase I ("Images of Potential") introduce descriptions of the 17 promising practices featured in this report: (1) Connections: the Cross-District Classroom; (2) Informed Students Make a Difference; (3) Channel Seven Kids News; (4) World 2000; (5) Learning in a Tech Room; (6) Agriscience with a Laptop; (7) MATEC for Success: Reaching At-Risk Students; (8) High Tech Art; (9) A New Language, a Proud Cultural Heritage; (10) Home and Hospital Learning Environments; (11) Cooperative Learning at West Anchorage High; (12) Kids Together: Writing across Grade Levels; (13) An Educational Role for Computer Games; (14) The Science Project Hotline; (15) Fairy tales from the Heart; (16) Forecasting the Future; and (17) The Future of History. Each description includes the school in which the practice took place, the grade level, the students involved, subject, technology required, and contact persons. Brief discussions of the educational trends and issues suggested by these practices conclude the report. (DB)

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he journey into *Learning Tomorrow* has begun.

It is a journey different from that taken by educators in the past. It is a journey which requires new ways of thinking about teaching and learning, grounded in sound concepts of what future citizens and workers will need to know and do. It is a journey which also requires an understanding of the role and potential of technology as a powerful force for improving and restructuring education.

To encourage and support educators in their quest for new visions and new practices, the National Foundation for the Improvement of Education (NFIE) initiated Learning Tomorrow—a program designed to support and stimulate educational restructuring through innovative uses of technology.

In the first phase of the program, NFIE asked leaders from business and industry, experts in technology, futurists and educators to address the question of what teaching and learning should look like in schools of the future. The resulting publication, *Images of Potential*, contains six scenarios which offer a glimpse of learning environments radically transformed through the use of technology. Students become independent, skilled and self-directed learners who know how to solve problems and work in collaboration with others. Teachers become guides, coaches, mentors and decision-makers. The classroom opens outward to become a stimulating and creative learning environment where many resources, including technology, are used to enhance student learning.

In the second phase of the program, NFIE conducted two nation-wide calls for Innovation in Practice, inviting teachers to describe their work in using advanced technologies in reshaping the environment in which students learn. This publication, *Images in Action*, contains brief descriptions of the most promising practices submitted by teachers, as well as an analysis of the trends and issues which the practices suggest.

Images in Action highlights the progress teachers have made in using technology to restructure schools. It is a glimpse of what is possible, of where we are, and of work that remains to be done.

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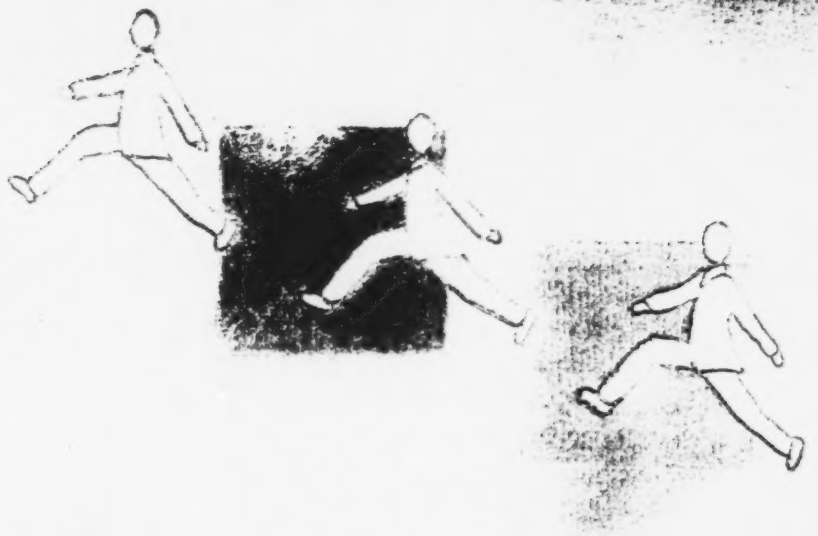
New practices begin with new visions. Nowhere is this more true than in schools where a growing number of teachers are experimenting with ways to harness the power of information and telecommunications technology to enhance teaching and learning. While technology is far from being fully integrated into the education process, progress is being made.

The practices described in *Images in Action* represent first steps toward understanding the full potential of technology to support student learning. The teachers profiled in this report have begun a complex process of exploring what is possible. Taken together, their innovations can help guide and inform future work.



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NFIE believes that teachers, those most intimately involved with students and learning, must play a central role in restructuring classrooms and schools. Interviews with Learning Tomorrow teachers confirm recent research findings showing that teachers need greater opportunities to learn enough about technology and its educational applications to be comfortable or even especially willing to include it in their instructional strategies. The experience of teachers who have integrated technology into their teaching repertoires suggests that the process takes as long as six years. Since much of the initial experimentation has taken place outside of normal work responsibilities, it seems reasonable to presume that more opportunities for training and experimentation could significantly reduce the time it takes for teachers to learn to use technology effectively to reshape the learning environment.

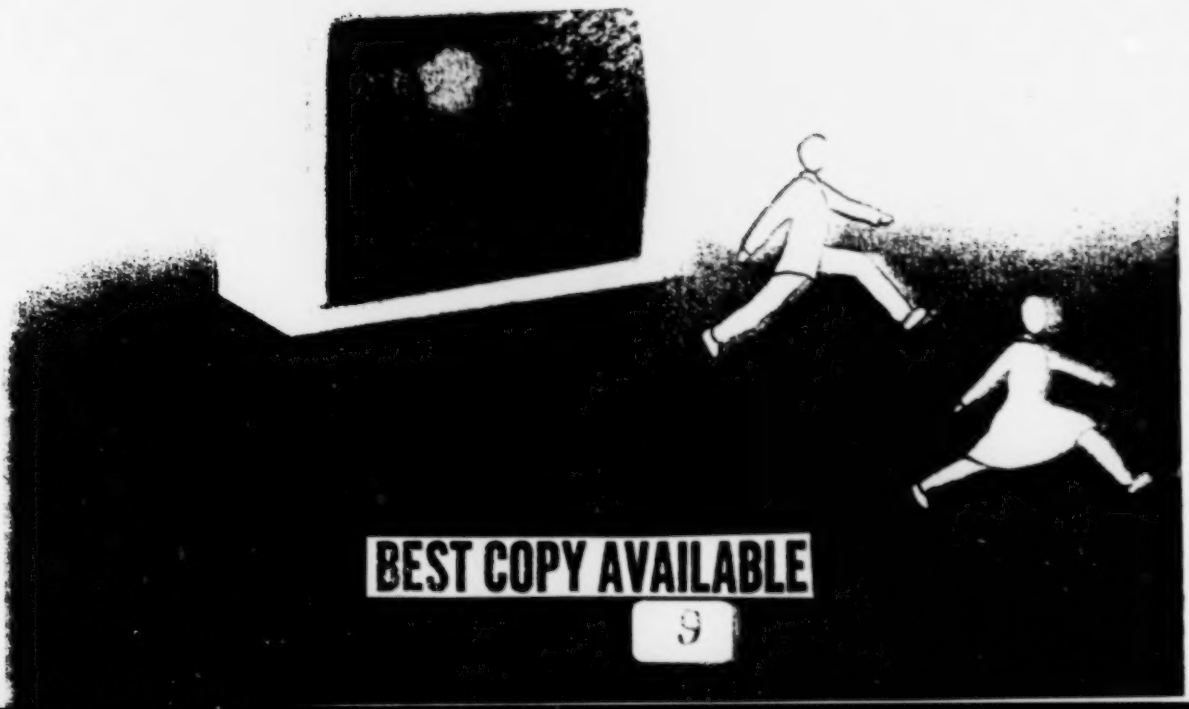
The results of a recent survey of teachers who are skilled users of technology points to a common pattern of growing sophistication in the use of computers in the classroom:

> Initial practices and approaches tend to be similar to familiar well-structured classroom technologies (e.g. workbook), more focused on reinforcing directly what is already being taught or, for particular groups of students, providing special opportunities. These practices continue, but play a lesser role over time as teachers become more expert and comfortable at integrating technology with teaching. Gradually teachers are able to manage more expansive uses that differ from more familiar technologies, that afford richer learning opportunities for all students, and that may engender new approaches to the curriculum itself.
>
> (Sheingold, Karen, Martha Hadley, *Accomplished Teachers: Integrating Computers into Classroom Practice.* A Report of the Center for Technology in Education at the Bank Street College of Education, 1990.)

As the profiles in *Images in Action* suggest, the use of technology can result in teaching strategies that reach beyond basic word-processing and drill and practice. As teachers become more skilled with technology and begin using it in ways that enrich and challenge traditional pedagogy, they discover that the technology not only enables them to change the way they think and act, it compels them to do so.

he promise of technology for education lies in its power to improve student learning. In a most basic sense, technology becomes a catalyst for the restructuring of schools by facilitating and increasing opportunities for constructive changes in the learning environment.

In the practices contained in *Images in Action*, teachers do not focus on the machinery of technology. They look, instead, at the ways in which technology can enhance teaching and learning—the opportunities technology offers for fostering the development of higher order thinking skills, for motivating students and for stimulating purposeful activity.



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These practices emerged from a simultaneous and sustained exploration of 1) strategies for improving learning and 2) the capabilities of technology. As teachers move through this process and develop practices that have positive effects on student learning, they find themselves looking at their roles, curriculum, instruction and assessment of learner performance much differently. Grassroots restructuring has begun.

As discussed below, these uses of technology for restructuring have significant implications for some of the most resilient organizational features of our education system.

Changing Roles

Through the use of technology, the traditional roles of teachers and students are changing. Teachers increasingly move away from the role of presenter and knowledge provider to act as collaborators, researchers, mentors, facilitators and long-range planners. In high technology environments, teachers are better equipped and empowered to perform the roles of skilled diagnostician and decision-maker that have always been essential to good teaching.

Technology can provide increased opportunities and incentives for students to become more active, skilled, and self-directed learners who can define and solve real world problems. They assume greater responsibility for the pace, style and, sometimes, the content of their learning. This is possible because more sources of information are available in the learning environment. In addition, the sources of information and the mechanisms by which they are conveyed or become available in the learning environment permit manipulation and re-ordering of content by students working independently of teachers.

Students in innovative education experiments also are emerging as effective teaching partners who contribute to the skill development of their classmates and even of their teachers. For students, increased productivity and an experience of success inspired by these new learning environments result in enhanced self-esteem and confidence.

The changes in the roles described above represent a restructuring of the student-teacher relationship in the learning process. The shared responsibility and shared effort for learning which develops, contribute to creating dynamic and productive learning environments.

Time

Time is the element of both students' and teachers' work that is most immediately affected by the introduction and use of technology. It takes time to learn how to use technology—time to learn, to study, and to experiment. Anyone who has started with even the most user-friendly hardware and software for word

processing will recall how many steps and missteps there were between merely typing faster and producing the dazzling graphics and other products that are shown on the covers of the users' manuals. Most users master only a small portion of functions included in the standard word processing packages. Once the basic skills are mastered, even more time is required to effectively incorporate them into daily tasks or to teach these skills to students and colleagues.

Technology can dramatically alter the pace of instruction, an important aspect of the allocation of time in schools. Some pupils may move quickly using computers to assist them in basic instructional activities. For others, progress through the curriculum may be slowed as they use the computer and other technologies to explore a topic in more depth—to review more information or to solve more problems associated with it.

Altering the pace of instruction has important implications for the organization of the school day. Use of computers and other technology may challenge the division of the school day into six or seven blocks of time and the general assumption that instruction should proceed on the same schedule for all students throughout the year. Students seriously engaged in writing and editing a newsletter or organizing a set of graphics to augment a report on a science project are likely to find it both difficult and frustrating to fragment their efforts into 45-minute segments spread over 10 school days. Teachers who use technology often report that students work through lunch hour, in the morning before school and late into the afternoon. This enthusiasm and commitment is a refreshing change, but it is also persuasive evidence that student work cannot be completed in the confines of a normal school schedule. Extensive and thoughtful use of technology challenges our assumptions about the utility of traditional school schedules and points to the need for a restructuring of time available for learning.

Curriculum

Technology puts vast amounts of knowledge at the students' fingertips. Enormous data bases on every imaginable topic can be made available for study in every area of the curriculum. A single compact disc can contain an entire encyclopedia or a complete collection of great literary works. Telecommunication links through satellite transmission systems can bring much of the world into any school or classroom at almost any time of the day. These are all exciting possibilities for expanding education. They also challenge the frameworks of traditional curriculum design.

Technology expands the scope of knowledge in two dimensions: it allows for wider range and greater depth. The assumption that instruction should cover the greatest possible breadth of information—from the Stone Age to the Space Age or the Greek tragedies, the Canterbury Tales, Goethe, Shakespeare,

Ibsen, and the American poets and playwrights of the 20th century—in a single year is as deeply entrenched as the standard allocations of time.

Clearly, students need to be exposed to a wide range of information to be able to master ideas and develop the skills necessary to become competent learners and active, productive adults. Nevertheless, as Fred Newmann, a noted researcher in curriculum development and education reform recently observed:

> "This legitimate need for a certain degree of coverage has fostered the illusion (firmly held by professional educators and the general public) that it is possible to teach a reasonably comprehensive sample of all of the worthwhile knowledge that is currently available. We are remarkably unwilling to accept the consequences of the knowledge explosion."
>
> (Newmann, Fred M., "Can Depth Replace Coverage in the School Curriculum?" *Phi Delta Kappan*, Vol. 69, No. 5., January 1988, p. 347. Full pages 345-349)

The practices in *Images in Action* which involve students in tasks such as the analysis of data bases, the development of plans and the presentation of proposals and products reflect a preference among teachers for depth over breadth of coverage. They represent a restructuring of parts of the curriculum to foster the development of higher order thinking skills.

Instruction

The choice between breadth and depth of coverage in content is a useful starting point for examining some of the implications for the work of teachers as more and more technology is introduced in schools. In school programs which concentrate on breadth of coverage, guiding students through a wider range of knowledge is a relatively easy task, made even easier by the availability of information processing technology. The intellectual demands on both students and teachers are relatively light, if only because there is little time to deal with serious intellectual issues. Further, if there is a premium on "getting through" a large area of content, there will almost certainly be a premium on standardization, which, in turn, reduces the complexity of classroom management requirements.

If there is an emphasis on increased depth, the teachers' tasks change in many ways. Teachers may, for example, assume responsibility for helping students organize large bodies of facts as they marshal evidence to define and solve problems. They may push them to seek other information and to consider alternative solutions. High school students, for example, can easily access extensive data bases on public policy issues in health, education, welfare, employment and finance. They can use this information to pose and address important questions. In the environment described here the volume of student writing, not

Technology

A
Catalyst
for
Restructuring

to mention other products, increases, becomes more diverse, and probably is of better technical quality. The teachers' task of preparing for instruction as well as evaluating student performance becomes more complex as students demonstrate higher-order thinking skills.

The increased use of technology as a tool for learners will almost certainly result in a decrease in the need for teachers to be "presenters" of content. Instead, teachers will become "organizers" of increasingly large and varied sources of information.

If the new learning environments open the doors to student learning and intellectual development in a broad range of areas and if these same environments encourage and support creation of products of high quality, what are reasonable expectations for teachers as "instructors"? Technology can be a powerful tool for teachers and can free their time for more intellectually rigorous tasks as they work toward the answer to this question.

Technology also supports the restructuring of instruction in a variety of indirect ways. A personal computer on a teacher's desk can store an enormous volume of information. It can keep records of student progress and attendance. It can store and organize lessons and assessment instruments. When it is linked to other data bases and computers, it can provide access to information about good practice and research. It can put the teacher in direct contact with other teachers to share ideas, information and messages of encouragement and support. Electronic networks that serve this function already exist.

Assessment

Much of the technology available for drill and practice and problem solving is designed to provide constant, consistent and positive or non-threatening feedback to students. There is solid evidence to suggest that these systems are effective for basic instructional activities. The built-in assessment mechanisms let both students and teachers know how the students are progressing. They can also greatly facilitate record-keeping. Technology used in this way essentially replaces, but does not alter, traditional approaches to teaching. Similarly, the assessment procedures follow standard assumptions and formats for measuring student learning.

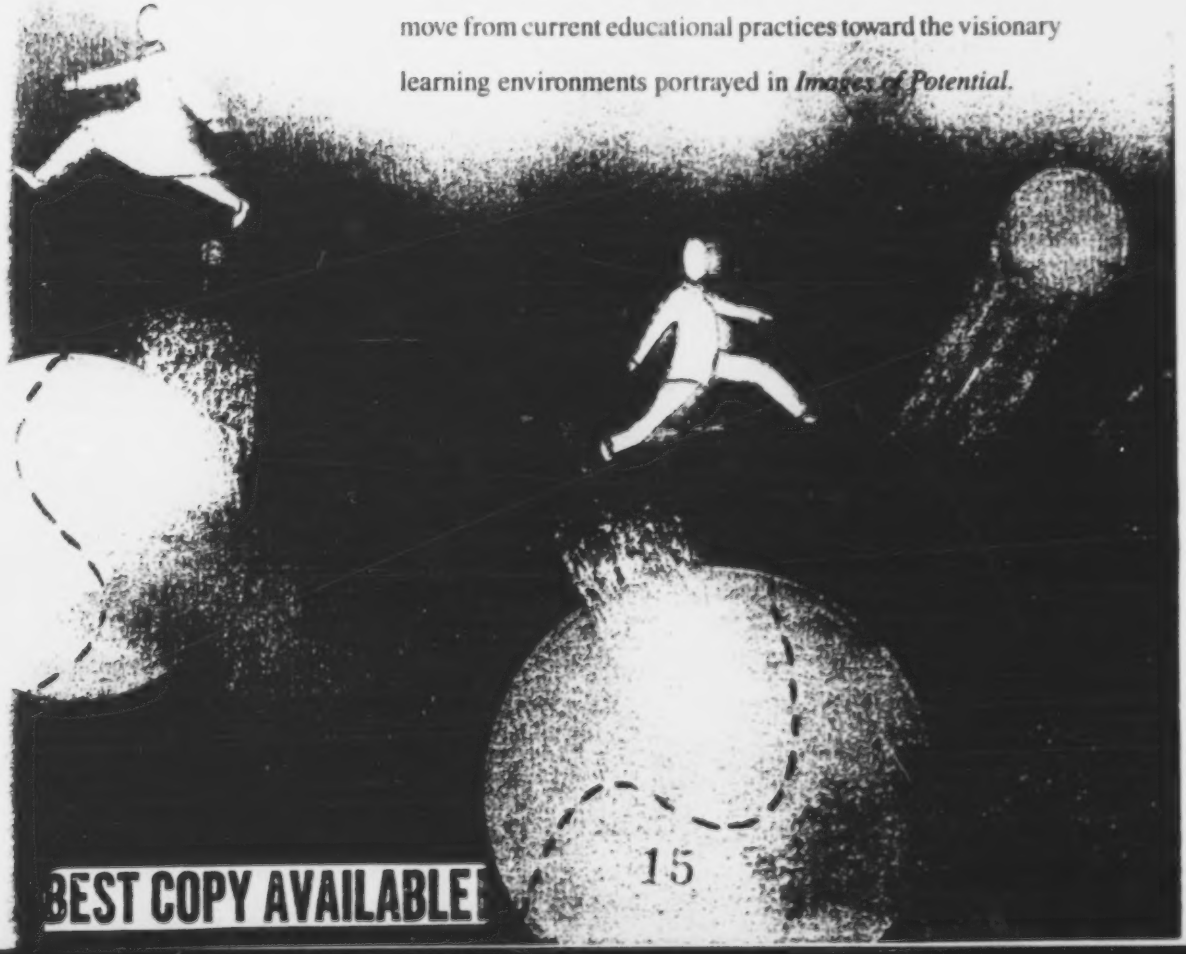
The emphasis on student products and increased opportunities for skill mastery made possible by more creative use of technology pose new challenges for assessment. This is due to the fact that products engage students in activities such as planning complex projects, analyzing and synthesizing information, evaluating ideas and presenting new learning in usable ways.

An example of one emerging strategy that provides an alternative to traditional testing is portfolio assessment. Samples

of students' work are compiled in portfolios. These might include examples of finished products and documents which describe the process used to develop the products. Teachers' notes on student progress, student self-evaluations and notes from student/teacher conferences frequently are included. Specially trained evaluators then review the contents of each portfolio to ascertain overall student progress. This strategy permits examination of individual sets of products and, at the same time, it allows a degree of standardization. The portfolio itself stands as tangible evidence of mastery and competence which can be shared with prospective employers or admissions officers at other educational institutions.

he design and implementation of the practices profiled here offer important lessons and insights into how teachers and others learn about and test the possibilities for using technology to improve education. As all of the teachers who have developed the practices agree, their efforts are significant but not the final points on a continuum of possibility yet to be fully defined. Much remains to be tried and tested. In the meantime, the progress and preliminary outcomes which the teachers have described are very much worth examining. What is presented here is only a brief snapshot of the interactions that the practices support. Contact information has been included for each profile to provide an avenue for further questions and discussion.

The profiles include a variety of information about how to move from current educational practices toward the visionary learning environments portrayed in *Images of Potential*.



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In *Images of Potential*, 12 common themes or elements of alternative organization of education run through the visionary scenarios. They include:

A central focus on student characteristics and individual learning styles rather than on the machinery of technology.

A concern that technology serve all learners, including those at-risk and disabled, to reduce the gap between the information-rich and the information-poor.

Students applying their knowledge in purposeful activities, e.g. providing assistance to the community, working with other students on global issues, thereby rendering relevance, practicality and societal value to their education.

Learning environments which extend beyond the walls of the school, often involving community members and others not traditionally associated with student learning.

Interdisciplinary approaches to curriculum often involving some form of teaming teachers from different subject areas.

High expectations and the belief that students are capable of solving complex problems.

A belief in the importance of utilizing existing and emerging technologies and researching their full potential for supporting education.

Increased student responsibility for their own learning and the learning of others.

The application of a mixture of technologies which extends beyond the classroom computer.

A balance of technology-facilitated and human-facilitated learning.

Flexible use of facilities, time and human resources.

Sensitivity to the development, health and well-being of the whole learner rather than education limited to academic development.

These themes form a useful framework for thinking about the ways technology is being used to change and restructure schools. The also provide a guide for examining the progress represented by the following practices. If the six scenarios in *Images of Potential* help address the question "What's possible in the future?" the hard work and experience behind the practices in *Images in Action* help address the question: "How do we get there?"

From Ideas To Action

Profiles of Current Practice

Practice 1

Connections: The Cross-District Classroom

Wayne County, Michigan, school districts comprise a challenging patchwork of diverse racial, ethnic, religious, socioeconomic and political groups. By designing a cross-district classroom learning environment to bridge the chasm between disadvantaged and affluent schools, Keith Zook, John Maunu, and Jerome Sullivan are combining talents to meet this challenge.

"Connections: The Cross-District Classroom" is a network of data bases and telecommunications systems tied together by a coordinated curriculum among four high schools. Students collaborate on projects in which they study global issues through a five-phase program of community study, simulation, issue analysis, action planning and plan presentation.

Students work together in teams to investigate and share information on the their social, political and cultural environments. In cross-district teams they identify such focus topics as human rights, world health, education, the environment, and global distribution of wealth.

The teams then research and analyze these issues, explore possible solutions, and work across district lines to develop a comprehensive action plan. They communicate by means of on-line telecommunications, telephones, fax, and mail. The teams take part in a high-tech conference where they meet with experts and leaders in business and industry to perfect their plans. Aided by multi-media technologies, student teams then present and defend their action plans in an inter-district forum attended by invited experts from business, industry, universities and social organizations.

Each "Connections" classroom is equipped with student research, production and communications centers, providing the means for students to develop joint products. Teleconferencing and facsimile are used to connect students and are used by teachers for planning, curriculum development and coordination. The project has created a model of the teacher's role as curriculum designer, co-learner, and facilitator, while fostering the role of the student as worker, researcher, communicator, peer-teacher, and creative problem-solver.

Contact: Keith Zook
School: Grosse Ile Township Schools, 23270 East River Road, Grosse Ile, MI 48138 including Highland Park High School (contact Jerome Sullivan) and Grosse Ile High School (contact John Maunu)
Grades: 9-12
Students: Urban, lower-middle income, African-American, Hispanic, Middle Eastern, Native American; Suburban, upper-middle income, Caucasian, Asian
Subject: Multi-disciplinary
Technology: Computers, CD ROM, interactive video, data bases, modem, camcorder, facsimilie

A four-week program combining technology with community involvement is giving high school seniors in a Minnesota social studies class a chance to shape the future. Anoka Senior High students work in teams to research, identify, and articulate social and economic problems affecting the state in a process that begins with a presentation by a State Planning Agency official about the state legislature's 15 top priorities for Minnesota's future.

Student teams, which vary by learning style, gender and birth-order position, examine three comprehensive data bases which provide detailed information on 87 Minnesota counties, 49 states, and 170 nations to analyze issues such as health care for the elderly, wetlands preservation, and international trade. They discuss public policy on issues that contribute to tensions in the regional economy with a state official. With the aid of school computers and telephone interviews with local experts, students then develop a document that includes their recommended solutions, data supporting their positions, and effective graphics and maps they have designed.

The teams present their proposals to the class in a simulated legislature, complete with mock lobbying and closed door negotiations. The clearest, best-substantiated proposals are selected by class vote. Selected teams then use their materials and powers of persuasion again in a formal presentation to Minnesota state officials.

Seniors leave Mittlefehldt's class with a set of technical and personal skills that are invaluable. They learn how to work effectively in groups to identify, define, support and articulate creative solutions to state problems. The intangible benefits include not only leadership skills, but a sense of empowerment. Students' experience gains meaning and drama from the capability of the technology to connect them to real data on the community, and from real-life, real-time involvement with Minnesota decision-makers.

Contact: William D. Mittlefehldt
School: Anoka Senior High, 3939 Seventh Ave. N., Anoka, MN 55303
Grade: 12
Students: Suburban, middle income, primarily Caucasian, honors students
Subject: Social Studies
Technology: Apple IIc computers, Appleworks, IBM compatible PC, data bases

Practice 3

Channel Seven Kids News

Fifth grade students in Lake Charles, Louisiana, are in the news—"Channel Seven Kids News." This ambitious and highly successful multi-media experience involves students with a wide array of video and audio technologies while sparking interest in current events. The three-week project, which culminates in the children's production of a thirty-minute video news show, was designed to combine language arts and social studies skills with the tools of the information age.

Students brainstorm and then outline the segments of their broadcast. They delegate areas of responsibility for each segment. Working in groups, students use a word processor to draft, edit, and rewrite their scripts for news stories, interviews, commercials, and weather and sports reports. After honing their interviewing techniques, they set out into the community armed with scripts and camcorders to shoot and re-shoot news stories and commercials. Students learn the value of perfecting their product as they edit, re-edit, shoot and re-shoot segments to get them "just right."

Students preview the film footage using the same procedure that the station uses to outline the format of the program. Using "VCR Companion," the students create the introductory, transitional, and closing screens to tie the broadcast together. Linking the computer and two VCR's, students edit the original tape and add the computer generated graphic "special effects." Sound is added directly to the graphics segments using a VCR with audio-dubbing capabilities and a student's jam box.

Parents and community members have been integral to the success of this project. Parent volunteers assist students in filming news segments and arranging interviews with busy local celebrities. Businesses are advertised in the student-created commercials. Reporters and anchors from the local television station coach students on news reporting, filming and broadcasting. Children themselves persuaded the news director to allow them to film anchor segments and sports and weather reports on the real set. After approximately three weeks of work, the final product was "premiered" at an exhibit in the local shopping mall. "Channel Seven Kids News" was a hit.

Contact: Sheryl Abshire
School: College Oaks Elementary School, 3618 Ernest Street, Lake Charles, LA 70605
Grade: 5
Students: Urban and suburban, lower to middle income, primarily Caucasian
Subjects: Language Arts and Social Studies
Technology: Apple IIgs computers, Imagewriter II printer, VCR, camcorder, video and audio dubbing cables, VCR Companion software

Students from the United States and the Soviet Union are separated by great geographical distances and cultural differences, but the innovative and cooperative implementation of telecommunications technology in project "World 2000" has created a single classroom for high school students in Alaska and those in the Babushinski District of Moscow. Teachers and students across the world use electronic mail and computer conferences to share personal experiences and research findings on contemporary global health issues. Their goal: to develop a collective vision of the world's health in the year 2000.

Working in cooperative learning groups, students research such issues as the greenhouse effect, depletion of the ozone, overpopulation, nuclear meltdown, and appropriation of food resources in keeping with the thematic focus on world health. They then are ready to exchange information, attitudes, and perspectives on essential questions with their foreign counterparts via "on-line" communications. Two computers are located in the Juneau classrooms and one computer is available in the Moscow high school. Every week, each class sends several messages containing questions and comments. Messages arrive at their destination only six seconds after they are sent, but the 12-hour time difference means that responses generally come the following day. Students then combine information from their research and telecommunication exchanges and write essays on the questions of how to effectively deal with the common concerns we presently face, and the global effects of both resolving and not resolving the problems.

This project expands the traditional learning environment as students come to see themselves as global citizens, capable of working in collaboration to address complex issues through telecommunication technologies. Students also build valuable computer and telecommunication skills that they will use throughout their lives. They have formed personal as well as study relationships with the foreign students and frequently exchange tokens of American and Soviet culture in friendship. Students write about their experiences for the school newspaper. Together with their Soviet counterparts, they also are developing a comprehensive publication to present their research on world health.

Contact: Nancy Seamount
School: Juneau Borough Schools, 10014 Crazy Horse Drive, Juneau, AK 99801
Grades: 9-12
Students: Urban and suburban, middle to upper-middle income, primarily Caucasian, U.S. and U.S.S.R. students
Subjects: Health and Biology
Technology: Apple IIe computers, modem, telephone

Practice 5

Learning In A Tech Room

At the Hemingway School in rural Idaho, every student has the opportunity to learn about technology and hone critical thinking and problem solving skills in the school's hands-on TECH room.

The TECH room (Technology Education Center at Hemingway) is a classroom that has been converted into various technology learning centers—a darkroom facility, computer lab, sound room, kitchen/chemistry center, and an "exploratorium" loft area. All 400 Hemingway students spend one class period per week working with lasers, computers, robots, commercial data bases, communications satellites and modems to solve both hypothetical and real-world problems.

By coordinating the curriculum with teachers throughout the school, teacher Terry Thode organizes stimulating activities that challenge students to expand what they are learning in other classes. The result is some startling transformations of humanities, math, communications, science and environmental curricula. Youngsters learning geography, for example, study the communications satellites in the Clarke Belt, learn how geosynchronous orbits work, then determine continents in each satellite's "footprint" area.

Students at Hemingway are excited about learning in this high-tech environment and often spend recesses and after school time in the room working on projects. Some students who experience little academic success in regular classes become "stars" in the TECH room. Students work independently and in groups, and often take projects home to enlist their parents' assistance in such activities as product testing and model building.

Direct involvement with parents and those outside the education sector is extensive in this innovative program. Not only do they manage fundraising activities, but up to 40 parents and community members serve as resource speakers and volunteers for the program each year.

Contact: Terry Thode
School: Hemingway School, P.O. Box 298, 1201 Campus Drive, Ketchum, ID 83340
Grades: Kindergarten-6
Students: Rural, all income levels, primarily Caucasian with growing percentage of Hispanic students
Subject: Interdisciplinary
Technology: Macintosh SE, Apple IIe, and Amiga computers, CD ROM player, facsimilie, modem, VCR, digitizer, lasers, robots, Camcorders, MIDI, Satellite dish

Practice 6

Agriscience With A Laptop

At Taylor Middle-High in Florida, students' work has a direct impact on the success of the region's economy. Seventh to twelfth graders collaborate with University of Florida scientists, St. John's River Water Management District officials and local farmers to interpret data and run experiments to improve growing methods for the region's primary crop, the leatherleaf fern.

The Taylor Fern Research Center, equipped with the latest agriscience technology, helps make learning relevant and meaningful for students of agriculture. The program enhances the state-mandated agriculture curriculum with bi-weekly field study days, and students gain direct experience with the methods and tools of agricultural research. Students record data readings from sophisticated agriscience equipment like flow-meters, pressure gauges, injection ports, ball-valves and an elaborate thermocouple system on the laptop computer they tote with them to the research lab. Back in the classroom, students analyze and interpret the data. They communicate their findings and questions via modem to scientists and fellow researchers at the University of Florida.

Learning is extended beyond the regular classroom experiments for many students. Eighty percent of agriculture students participate in independent and group "Supervised Agricultural Projects," real projects which produce information used by fern growers. To address the problem of potential water shortages, for example, an agriculture student at Taylor is conducting research for an evaporation study that will be used to set water management guidelines for fern growers.

Benefits of the program also extend beyond the classroom. The community gains the information it needs to keep its primary industry viable. Students gain practical experience with agriculture's most sophisticated tools and the knowledge that their work can have a significant impact in their community.

Contact: Jana Register*
School: Taylor Middle-High School, 100 E. Washington Ave., Pierson, FL 32180
Grades: 7-12
Students: Rural, middle to lower income, primarily Caucasian with growing percentage of Hispanic students
Subject: Agriculture
Technology: IBM Compatible PC, IBM Compatible laptop, modem, Agriscience equipment (flow-meters, gauges, injection ports, ball valves, thermocouples)
**Practice submitted by Ronald Eric Matthews*

Practice 7

MATEC For Success: Reaching At-Risk Students

By attending to students' individual characteristics and maintaining high expectations, teacher Gail M. Morse creates a learning environment that breeds success for at-risk students. The Media and Technology Enrichment Center (MATEC) is constantly evolving to fit the needs of the students. The program began as a "school within a school" with learning taking place in interdisciplinary clusters based on student learning styles (visual, auditory, tactile, kinesthetic). Seventh grade students identified as at-risk by their sixth grade teachers spent the majority of their classroom time at MATEC engaged in purposeful learning using computers, laserdisc players, a satellite disk, and science probeware.

In a project on acid rain, students tested soil samples from a local housing development. Other projects include the development of a closed circuit TV for the entire school, a satellite to bring the "smurfs" from the French satellite to the French classes, and research on such topics as deforestation.

The program includes STATT (Students Today Are Touching Tomorrow), in which the previous year's at-risk seventh graders teach many of the newly identified at-risk students in lunch-hour and after-school sessions. STATT gives students a heightened sense of responsibility for their own learning and the learning of others.

The success of this program can be measured not only by the drop in the absentee rate and the rise in math test scores, but by typical scenarios which occur within the MATEC setting: students refuse to go to lunch because "lunch interferes with learning," or they complain that school is "not open on Saturday." A full 90 percent of last year's MATEC students moved into leadership roles; 74 percent made the A or B honor role; and MATEC students make up 50 percent of the advanced science students. Approximately 4 percent of those identified as at-risk were subsequently recognized as academically gifted.

At least three days a week, the center hosts visiting educators from as close as neighboring North Carolina towns and as far away as Moscow. Through peer-to-peer teaching, the MATEC magic now touches more students than ever—at J.M. Alexander Junior High and beyond.

Contact: Gail M. Morse
School: J.M. Alexander Junior High School, 12201 Hambright Road, Huntersville, NC 29078
Grades: 7-9
Students: Rural, urban, primarily Caucasian and African American, students characterized as "at-risk"
Subject: Multi-disciplinary
Technology: Satellite Disk, Telecommunication networks with Iris, Apple Link, and National Geographic, Laserdisc players, Macintosh, Apple IIGS, Apple IIe computers, Science Probeware, and an Apple Scanner.

In an Alexandria, Virginia, high school art program, information age technology stands beside clay and paint as a popular expressive medium. Students from varied socioeconomic and academic achievement backgrounds at T.C. Williams High School spend five class periods, the equivalent of one week, developing computer animation projects.

The advanced computer and videotape technology excites students to mold reality in creative new ways as they gain a broader and deeper understanding of both art theory and technique. Preparing the scripts and storyboads they will transform into animation frames on the computer, students exercise their language, logical thinking and problem solving skills. They record their productions on video cassette, and sometimes introduce external images and live action video into the animated product.

Instruction follows a new pattern in this art class. Individual training by the teacher is followed by peer-to-peer teaching as students themselves begin to work on their production with the teacher available when needed. This interaction encourages students to take on an increased responsibility for their own learning and the learning of others.

Motivated, enthusiastic students carry their computer graphics and animation skills into other curriculum areas as well. They employ the same technology they used for artistic expression as a tool for visual presentations in science and social studies. One student, for example, used computer animation in a science project to show the earth when it had only one land mass, and then animated sections breaking away to form the continents as we know them today.

These tools have enhanced students' learning not only through the animation project, but also in commercial design and advanced studio art classes where students produce work they will include in the portfolios they present to prospective employers and admissions officers.

Practice 3

Sign
Tech
Art

Contact: Cora Marshall
School: T.C. Williams High School, 3330 King Street, Alexandria, VA 22302
Grades: 10-12
Students: Urban, all income levels and ethnic groups represented, varied learning abilities
Subject: Art
Technology: Amiga 500 computer, Deluxe Paint III software, Digi-View Gold, Camcorder, Video Tape Recorders (VTR), SuperGen Genlock

Just twenty miles north of New York City a computer-based program helps ESOL students (English for Speakers of Other Languages) build self-esteem, confidence and language skills. The LEGACY project encourages students to celebrate their cultural heritages and family experiences as they practice their new language, English.

Each ESOL classroom at White Plains High School has a writing center equipped with three Macintosh computers where students produce essays, illustrations and newspapers about their family histories. The LEGACY project challenges traditional textbook methods of language learning by engaging students in research about their own cultures.

Students use cassette tape recorders to conduct family interviews, then translate and transform the oral into the written using the computer systems. They review one another's work and edit their reports based on the suggestions of their peers.

Coordinator Kathy Rehfield-Pelles says that using a word processor enhances language learning: "Because of the fluidity and flexibility of writing on a word processor, students come to view speaking and writing in English as a process which they are constantly experiencing, editing, and reworking." Students add to their written work with creative visuals designed on a variety of graphic and layout programs.

The LEGACY project opens up new possibilities for mainstream students as well as those of limited-English proficiency. Publishing the histories in the student newspaper gives the entire student body a better understanding of other cultures. These newspaper articles are used as source materials in the foreign language classes. In interdisciplinary sessions incorporating English, Foreign Language and Social Studies departments, students share perspectives on the LEGACY articles and themes. The students' written themes serve to promote better understanding of the high school students' rich cultural heritage.

Practice 3

A
New
Language,
A
Proud
Cultural
Heritage

Contact: Kathy Rehfield-Pelles
School: White Plains Public Schools, 500 North Street, White Plains, NY 10605
Grades: 9-12
Students: Recent immigrants from countries where English is not the primary spoken language
Subject: English as a Second Language
Technology: Macintosh SE computers, Laser Writer, Image Writer, and software such as MacWrite, MacPaint, and PageMaker

Doctors are not the only people making housecalls on homebound young persons in Maryland. An innovative teacher equipped with an Apple IIc and a mini-monitor travels to the homes of 4-6 students each day to instruct them on a one-to-one basis.

This computer-based facet of the Home and Hospital School is designed to meet the special educational and emotional needs of students whose diseases or handicaps confine them to homes, hospitals or institutions for four or more weeks. Because the student body of this "school" represents all grade levels and subjects as well as a broad spectrum of learning abilities and socioeconomic backgrounds, maintaining flexibility in curriculum presentation is crucial. Teacher Linda Royahn Copper discovered that the computer offers a way to personalize and customize instruction to meet special academic and personal needs.

With a keyboard in their hands and a guiding tutor at their side, students develop intellect, self-esteem, and computer literacy. They progress through a curriculum of carefully selected software and other materials that parallels "regular" school lessons at a rate that will prepare them for a smooth transition back into the classroom. This method of teaching provides students with a solid presentation of new material at the pace most comfortable to the student. Special tutorial computer software also allows students to easily review material when necessary.

These flexible lessons are maximizing the educational progress of Home and Hospital students who are held to the same academic standards as their regular school counterparts. Copper observes that students often seem to pick up new concepts more quickly, display higher levels of self-confidence, and overcome some learning anxieties. Emotionally handicapped students appear to especially benefit from the flexibility of the computer system. Nearly all students benefit from increased parental involvement. This creative, computer-assisted approach for teaching incapacitated youth has had extraordinary success in converting home and hospital into learning environments.

Practice 10

Home
And
Hospital
Learning
Environments

Contact: Linda Royahn Copper
School: Home and Hospital School, 6229 Falls Road, Baltimore, MD 21209
Grades: Kindergarten-12
Students: Urban, rural and suburban, all income levels, varied ethnic groups represented
Subject: Multi-disciplinary
Technology: Apple IIc

Practice 11

Cooperative Learning At West Anchorage High

In Anchorage, Alaska, Library, Science and English teachers are working together to keep students in school. West Anchorage High School teachers, recognizing that ninth grade is the year in which many students decide to drop out, have created a technology lab that provides a stimulating, interdisciplinary learning environment for students of all ability levels. Supported by an Apple "Equal Time" Grant, the technology lab has become the school's most popular classroom.

The computer lab was created to provide an engaging learning environment specifically for at-risk ninth graders. It now serves the entire school population. In a two-classroom space with three computers per hexagon table, students use information-age technologies daily to work on projects that integrate the curriculum with research, written and oral communication skills. Teachers design projects that foster flexible, cross-age and cooperative learning. In one science project, students identify a particular chemical element and create a Hypercard stack they then use to present information about that element to their teacher and peers. In another geology project, advanced science students work together with other science students to build stacks on geology topics. High school students also are paired with elementary students to create class directories and adventure stories. The computer lab is networked with computers and printers in the library, and the high school's network is linked to a network at Turnagin Elementary School in Anchorage.

The idea is spreading as Goltz, Frank, and Stephens share their success with their colleagues. West Anchorage High already has a second mini-lab, obtained through a grant won by ESL (English as a Second Language) teachers inspired by the possibilities they saw for their curriculum area.

Contact: Carol Goltz, Diane Frank, Mary Margaret Stephens
School: West Anchorage High School, 1700 Hillcrest Drive, Anchorage, AK 99517
Grades: 9-12
Students: Urban, all income levels, primarily Caucasian
Subject: Multi-disciplinary
Technology: Macintosh computers, scanner, ImageWriters, CD players, Laserdisc players, modems, MacRecorders, MacVision, LaserWriter, Solane R-Server

Students in Kansas City, Missouri, are doing ordinary things—but in an extraordinary way. Young writers from four elementary schools have united with high school journalism staff members to produce a school newspaper. This unusual collaboration produces not only a high quality finished product, but strengthens important academic and social skills. Together young and old students gain working knowledge of newspaper terminology and learn effective writing styles.

The production process begins when the first of four classes, first through sixth graders of varied learning abilities and social skills, is bussed to the high school. There, high school journalism and graphics students guide younger student partners at the computer. As the teams edit and type news stories the elementary students have already written, all students improve writing skills and grow more technologically literate and adept. Older students take responsibility for typesetting, designing and printing the newspapers on sophisticated equipment with assistance from the graphic arts teacher. The final result is a professional looking publication to share with friends and family that makes young and old students feel like professional journalists.

By working with the "big kids" at the high school, the elementary students gain self-esteem and pride in a learning environment that reaches beyond the four walls of the traditional classroom. The time and attention they receive from the older mentors instills confidence in their written communications and fosters a great sense of accomplishment. The older students develop patience and clear oral communication skills, as well as a feeling of pride, confidence and enthusiasm as they share their knowledge and experience.

Contact: Mary Lu Foreman
School: Center Senior High School, 8715 Holmes, Kansas City, MO 64131
Grades: 1-6; 10-12
Students: Urban, all income levels, primarily Caucasian and African-American
Subjects: Language Arts and Journalism
Technology: Apple IIe, Macintosh Computers, Compugraphic MCS 100 typesetting system, process photography equipment, Multilith offset duplicator

Practice 12

Kids Together: Writing Across Grade Levels

Practice 13

An Educational Role For Computer Games

From a quick glance at small groups of students gathered around computers playing games, it is obvious that something unusual is underway in the classrooms of this Stockton, California, intermediate school. Perhaps the instructional method is not obvious, but the results are. Teachers are using computer games to promote learning by fourth, fifth and sixth graders.

Van Buren serves students who have had difficulty with both academics and self-esteem. Reading levels are routinely two or more years below grade level, mathematics scores hover in the low teens, and less than one half of the students are expected to complete high school. Many come from households plagued by crime, addictions and domestic violence. Reversing the cycle of failure these students experience demanded creativity. A bright idea that works with Van Buren students is the incorporation of computer interactive adventure games into the school day.

Game playing stimulates the development of logical thinking, problem solving abilities, and cooperative negotiating tactics — vital life skills many of these students lack. Ignoring the skeptics, teacher Marci Rogers dug a computer out of school storage, brought in some interactive adventure game software from her personal library, and made her students play.

They play and they learn. Students who previously experienced great difficulties in academics, and consequently demonstrated little enthusiasm for learning, regularly attend school. Working in teams, students refine fundamental thinking and social skills as they progress through the computer adventures. They are more excited about reading and display more imagination. Students' individual successes in the adventures enhance their self-esteem, and the team setting fosters improved cooperation. As they are required to complete any classwork missed during their scheduled computer time, students are encouraged to take on greater responsibility for their own learning. Failure to make up the work results in forfeiture of upcoming computer time—a sacrifice few are willing to make. Scores on the California Test of Basic Skills provide testimony to the project's success: students average 50 points higher than in previous years!

Contact: Marci Rogers
School: Van Buren Intermediate, 1628 East Tenth Street, Stockton, CA 95206
Grades: 4-6
Students: Urban, lower-middle income, 75% bilingual minorities—Chinese, Hispanic, African-American, many students characterized as "high-risk"
Subject: Multi-disciplinary
Technology: Apple IIGS computers, Commodore, and Amiga computers, Adventure game software

"The Science Project Hotline" rescues students and teachers across the country from ignorance of the biological sciences. Combining distance learning technology with 20 years of classroom experience, teacher Donald Pottle shares details of nearly 1,500 life-science experiments that can be reproduced by fledgling biological scientists of all ages, experience, backgrounds, and interests in school and home laboratories. The result: students representing diverse communities, abilities, and ethnicities are gaining an exposure to the biological sciences far beyond the scope of traditional classroom presentations.

A general description of all of the projects is outlined in the "Science Project Hotline Resource Book." Videotapes, computer diskettes, teacher workshops, and on-line consultation also are available. Innovative teacher Donald W. Pottle is making it easy for other teachers to develop biology studies beyond the experiments. He provides information on materials resources, funding, professional scientist mentors and contacts, research laboratories, and biology organizations.

The projects described in the "Science Project Hotline" illustrate a teacher-initiated effort to reform the textbook approach to biology instruction too often viewed as dull. Pottle started by enlivening his own classroom lectures with demonstrations and experiments—ranging from reenacting medical practice in the 18th century to creating a mobile, 7-foot talking robot. Classroom activities are supplemented by student-tailored, independent, experiential learning projects, many of which are developed with the guidance of professionals in the Shrewsbury community. The projects foster students' individual creativity and inventive spirit while developing their sense of accomplishment and self-worth. Students gather information, interpret quantitative and qualitative data, and master present and future technologies. The posters, project boards, models, and displays that students develop to share their experiences overflow the biology classroom.

Contact: Donald W. Pottle
School: Shrewsbury High School, 45 Oak Street, Shrewsbury, MA 01545
Grades: Kindergarten-12
Students: Urban, rural, and suburban, all income levels, diverse ethnicity and learning abilities
Subject: Biology
Technology: Computer, modem, facsimilie, video tape, and other laboratory equipment

Practice 14

The
Science
Project
Hotline

Practice 15

Fairy Tales From The Heart

"Once upon a time in an inner-city middle school," the story of "Fairy Tales 1990 Style" might begin, "Language and Math teachers joined forces to teach 150 seventh graders in creative new ways." Teachers at Noe Middle School in Louisville, Kentucky, are part of a battle to combat the low educational achievement and high unemployment that plague their community.

"Fairy Tales 1990 Style" was designed to improve students' writing and problem solving skills, to familiarize students with the capabilities of modern technology, and to raise their self-esteem. The program begins with student review of classic fairy tales. Then the students create their own versions—updated, modern renditions reflecting current societal and personal values. Portfolios kept by the students show that the process of editing their stories strengthens their writing skills.

Student efforts are rewarded by publication of their stories in an anthology called "Fairy Tales From the Heart." They improve communications skills further as they work in cooperative teams to translate the published stories into video dramas complete with props and costumes. Technical skills involved in desktop publishing and video production are mastered with training and guidance from their teachers and technicians.

Students use the stories written in language arts class to generate challenging mathematical problems, which are published in "The Heart of the Problem." Math anxieties decrease in the lighthearted context of the fairy tales, and students hone their problem analysis and solving techniques. A third publication of students' writing at Noe, called "Writing in all Directions," is distributed to community members. The pride students feel as they become effective problem-solvers, published writers, experienced actors, and skilled technology users sends self-esteem soaring.

"Fairy Tales From the Heart" is real tale of success and innovation in urban Kentucky!

Contact: Sharon G. Shrout
School: Noe Middle School, Louisville, KY 40212
Grade: 7
Students: Urban, lower-middle income, primarily Caucasian and African-American
Subjects: Language Arts and Math
Technology: IBM and Macintosh computers, scanner, camcorder, projection computer, ImageWriter and LaserWriter printers, PFS Write, Microsoft Works, Aldus Pagemaker

Based on the concept that students learn most effectively through applied, interdisciplinary course work, teacher William Jordan has developed an innovative approach to teaching Computer Science that supports learning in other content areas. The Tavernier, Florida, practice encourages student-student, and student-content interaction by engaging students in purposeful, technology-based activities.

Students who participate in Jordan's year-long Computer Applications course undertake short-term and long-term interdisciplinary projects. Students use computer lab technologies to complete and supplement work for other classes in tasks that involve a range of complexity and technical skills. A short term project might involve the use of the computer to plot chemistry experiment results, allowing the student to create an effective graph that enhances his/her chemistry lab work. In one exciting long-term project, students created a multi-media presentation on whales and dolphins.

Lab work has also helped to spark student interest in meteorology through a weather station which students use as a research base for science projects. The mobile unit, complete with satellite dish, antennae, and radio receiver, serves students throughout the district. Students used the weather station to design and produce a hurricane tracking map, and marketed their product to raise two thousand dollars from local businesses towards the purchase of a new computer.

The lab is connected to a number of electronic bulletin boards, like GTE World Classroom, EcoNet system, Global Lab Project, and TERC. Multi-media capabilities were recently added. The project requires just one classroom that directly serves the 100 students enrolled in computer science courses. However, many students of other sciences work with the equipment, and the entire student body has access to the lab.

The award-winning project has been showcased in state, national, and international conferences, and has garnered support from a number of businesses and state organizations.

Contact: William Jordan
School: Coral Shores High School, Tavernier, FL 33070
Grades: 9-12
Students: Rural, urban, suburban, all income levels, primarily Caucasian with growing percentage of Hispanic students
Subject: Computer Science
Technology: Tandy 1000 and IBM computers, Laserdisc player, Weather Station: Satellite dish, Antennae, Radio receiver

Practice 16

Forecasting The Future

Practice 17

The Future Of History

"Involve me and I'll learn" is the motto of a History-Social Science lab in Beverly, Massachusetts. Cutting edge technology is revitalizing student interest in the humanities with purposeful learning activities that generate a sense of civic pride.

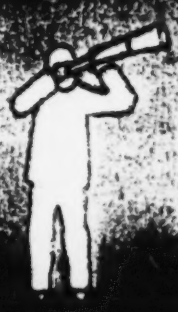
Computer lab work at Beverly High School serves as a complement to the existing curriculum by allowing the kind of in-depth exploration of a particular topic that encourages students to move beyond abstract data. Using technology for research of primary sources, students explore the human relationships and experiences behind the dates and facts of this early Massachusetts town.

After introducing a particular time period, for example, the History teacher moves students to the lab. There, using computers, modems and short-wave radio receivers, students begin researching what was happening locally during that time period. They examine school publications, yearly reports from the city, city census reports, immigration figures, industry profiles, literature, diaries and ships' catalogues to learn about the historical inhabitants of their hometown. The research stimulates students and makes them want to learn. With primary resources collected as part of a city archive project, the lab engages teachers and students in hands-on, historical research with a biographical focus. Students take pride in their work as they use the technology to practice the craft of writing history. By studying the early inhabitants of Beverly, students come to see themselves as agents of history. The study vividly demonstrates that the building blocks of history are everyday activities by people like themselves.

"Interdisciplinary work that is hands-on, relevant and meaningful to students is a key to better learning," says teacher Anthony Witwicki. "Learning becomes more exciting for everyone in a cooperative setting where teacher and student learn together."

Contact: Anthony Witwicki
School: Beverly High School, Beverly, MA 01915
Grades: 6-12
Students: Suburban, primarily Caucasian with a growing percentage of African-American, Hispanic, and Cambodian students
Subject: Humanities
Technology: Macintosh computers, modem, short-wave radio receivers, laserdisc/HyperCard, and CD-ROM player, microfilm readers and printer

Taken together, the preceding practices present a powerful composite view of learning environments in which technology stimulates and often restructures the learning environment. They represent benchmarks in a continuum of change that can provide starting points for others who are experimenting with technology in their classrooms and schools. The practices were developed in a variety of different settings and were intended to serve different purposes. Nevertheless, there are some basic commonalities in them and in the barriers teachers encountered that were identified from the teachers' written submissions and phone interviews.



Observations

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Focus on At-Risk Students

Many of the practices serve students who are at-risk of failure or of leaving school. These teachers have taken extra steps to change the experiences of these students who are generally unmotivated and unresponsive to traditional learning environments. The practices provide alternative learning environments which appear to increase the opportunities for success.

Technology contributes in several ways. Programmed materials and other hardware and software make it possible for students to complete tasks they start. The same tools also facilitate preparation of products which, in turn, build pride and a growing sense of self-worth. Increased self-esteem is important to all youngsters, but it is especially important to those with a history of failure and who face the prospect of an equally bleak future in education.

Attention to Individual Learning Styles

Technology opens the door for teachers to organize learning experiences around their students' individual cognitive styles. Several of the teachers have taken this opportunity to use technology to create highly individualized learning environments. Others have organized students for instruction in ways that build upon individual strengths and remedy weaknesses. It is especially noteworthy that some of the grouping strategies have led to the development of interpersonal skills which have subsequently contributed to increased learning.

Creating Products from Start to Finish

Almost all of the practices include opportunities for students to create products—essays, reports, newsletters, and multimedia products. Technology makes it possible for the products to be of high quality and to be prepared efficiently. This is satisfying in itself, but some of these teachers go further. They have defined sequences of student tasks that involve planning, design, preparation, revision, and final products. They have taken advantage of the technology to make these processes more efficient and compact and, as noted above, to increase the likelihood of success.

Extending the Learning Environment

As technology begins to change the traditional learning environment, opportunities for application of knowledge beyond that environment may change as well. The teachers in these programs have taken advantage of the technology available to them to focus their students' attention, learning, and productive energy on a variety of issues and problems of considerable social relevance.

Several of the practices put students in touch with students from other countries to study problems of mutual interest and concern. Other programs have a domestic focus and encourage students to think about problems and issues through cooperative learning and communication with students from different socioeconomic backgrounds.

High Expectations for Active Learning

The introduction of technology in these classrooms, by itself, reflects the fact that the teachers have high expectations for their students, and for themselves. They believe that more is possible. At the heart of these expectations is a strong belief that, when given the opportunity and the resources, students can become active learners and assume considerable responsibility for their own learning. The focus on products and the steps in product development which are central themes in instruction are examples of this perspective.

The payoffs are striking. Not only do students tend to meet and exceed the heightened expectations, but the fact that they do so often results in teachers raising their expectations still higher. In some cases, higher expectations by one teacher spreads to others in the building. In one school, a teacher reported that after looking at a set of papers written by students using a very basic word processing system, the principal exclaimed quite simply that he "had no idea that those students could even write."

Time and Other Resources for Program Development

Perhaps the most serious problem that these teachers faced was the lack of time for planning and development. In most cases, planning was done after regular tasks were completed. The most important exception to this pattern was when teachers were given time to write proposals to request support for their practices. There was, in most cases, too little time for training. In fact, most of the training was on-the-job. Teachers are accustomed to these arrangements and manage to work in or around them. Nevertheless, the absence of time for these key aspects of professional development is a serious problem.

Time was a problem in another way. With several striking exceptions, these practices were implemented as additions to regular instructional activities. This made already crowded days even more crowded. Not surprisingly, practices that replaced other practices appeared to be more successful and to have greater potential for expansion in the regular school program.

Most of the practices benefitted from the availability of external resources in the form of private sector grants or from local or state school improvement funds. In a few cases, community groups had come forward with resources, usually in the form of hardware and software. Overall, the teachers are both aggressive and resourceful in garnering financial support for these practices. They have been successful in marketing their ideas.

Support in the form of encouragement from building administrators and from the district level was an important ingredient in the majority of practices. Teachers had been encouraged to experiment and to seek resources, and they were recognized for their efforts.

Some of the teachers reported a decided lack of support, even opposition to their efforts. The reasons for this are not immediately obvious; however, the fact that it exists suggests that much remains to be done when it comes to educating educators about the potential of technology in contributing to efforts to improve and restructure education.

The single most important outcome from these practices is the spiralling interaction among increased student learning and productivity, the experience of success, increased self-esteem and confidence, and higher expectations among teachers and others. The effects of this upward spiral contribute to the intellectual and emotional development of all students. The contributions to the lives of those who are at-risk appear to be especially powerful.

In these practices, technology has made new and stimulating learning environments possible. Teachers are enthusiastic and committed. They have learned a great deal and are still learning. They continue to experiment, to examine the effects of their experimentation and to refine what they are doing. It is an on-going process which is underway every day.

Moving Forward

As these practices demonstrate, teachers and others are laying the groundwork for the future. Realizing the full potential use of technology in schools will require additional experimentation which builds on what we have learned to date. The challenge to teachers, administrators, policymakers, business leaders, and other education community members is to stimulate and support further experimentation. Through such efforts, the learning of today can become Learning Tomorrow.

Acknowledgments

NFIE acknowledges with gratitude the following professionals for their invaluable contribution to *Images in Action:*

Apple Computer, Inc. for their continued and exemplary commitment to improving education and empowering teachers. Their support helped make this publication possible.

The Hitachi Foundation for stimulating the use of advanced technologies for reforming education by supporting the first stages of Learning Tomorrow, including awarding recognition grants to the teachers whose practices are profiled here.

The NFIE Board of Directors for its vision and leadership, and for recognizing the potential of technology in restructuring schools.

The Learning Tomorrow teacher awardees for their pioneering efforts in using technology to improve teaching and learning.

Cheryl Kane and Nettie Legters for their substantial work in developing and implementing the Learning Tomorrow program and in editing this publication.

M. Bruce Haslam and Carrie Chimerine of Policy Studies Associates for their assistance in the preparation of this report.

Mary Amann and Tracy Slanger, NFIE's 1990 fall interns, who applied their interviewing, writing and editing talents to develop the practice profiles.

Ferne Carpousis, Robert McClure and Donald Rollie whose editing skills and suggestions helped shape the final draft.

Paine Bluett Paine, Inc. for their exceptional and consistently superb work in visually representing these *Images in Action.*

NEA Communications for their assistance in the editing, design and production of this publication. Special thanks to: Mabel Barker, Elvira Crocker, and Barbara White.

The staff of NFIE, who provide the commitment and support that contribute to the quality of all of the Foundation's programs: Kim Beury, Julie Bowens, Roberta Hochberg, Gwen Leak, Harry Mitchell, Gloria Tiongson, Tommie Person, and David Wallace.

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